Navigation System Simulation (NaSS)

Mark Lisney CEIWR-GR

2006 NETS Symposium

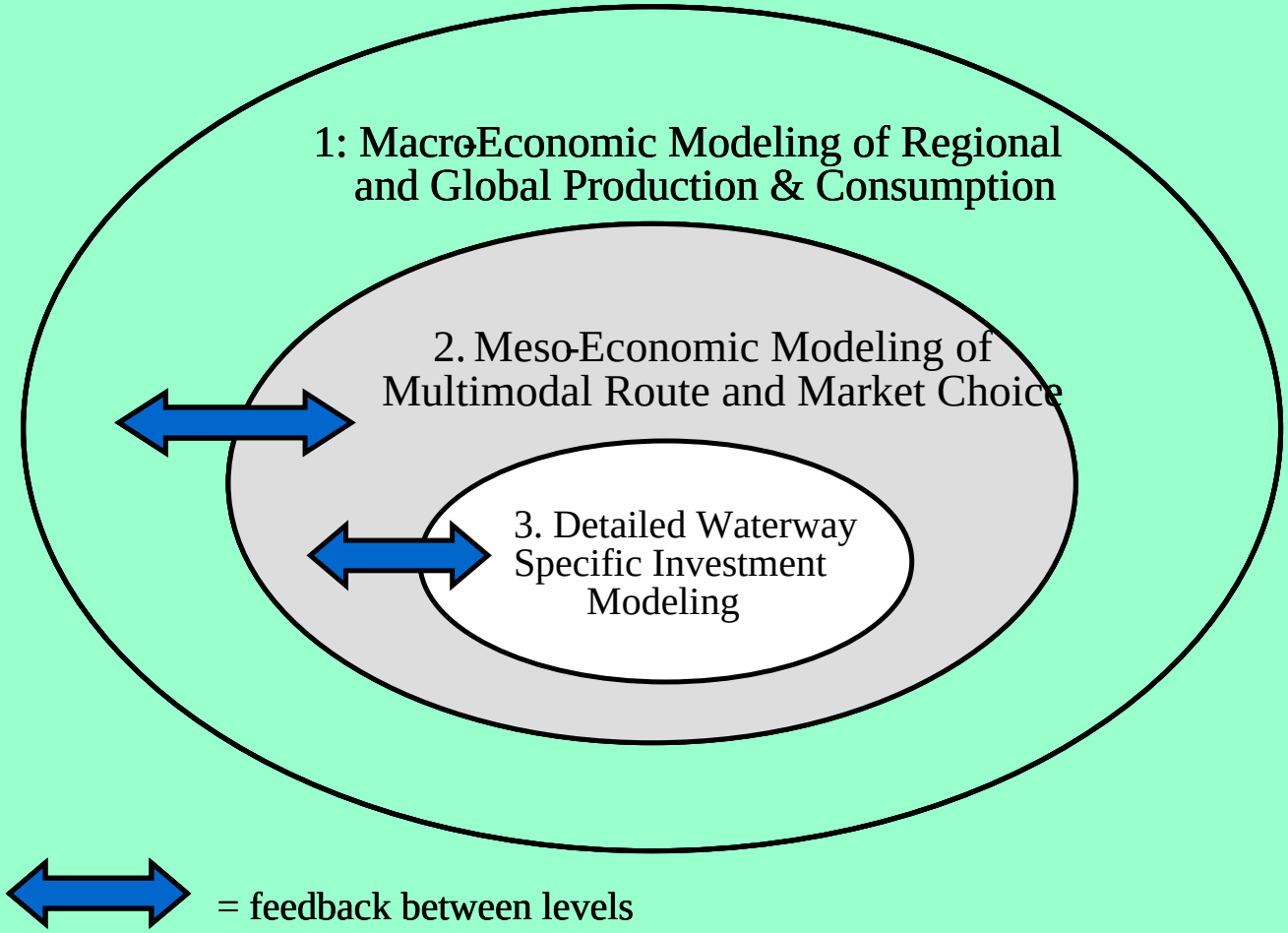
12-14 January 2006

www.corpsnets.us

NaSS Team

- Keith Hofseth, Buddy Langdon, Mark Lisney – Corps
- Cory Rogers – CDM
- Dick Males – RMM Technical Services
- Prof. Paul Schonfeld and Dr. Shiaaulir Wang – University of Maryland

NaSS Overview



Desire for Comprehensive Model(s)

- Complex Lockage Behavior
  - Internal lock representation
  - Interference
  - Multiple adaptive policies
- Reliability
- Shipper Response
  - Scheduled / Unscheduled Outages
- Investment Optimization
- Data Analysis and Pre-Processing

NaSS General Purpose

- Next-generation navigation simulation model
- Intended to serve as:
  - system simulator
  - driven by commodity demand
  - incorporating conservation of equipment
  - shipper response to scheduled and unscheduled closures
  - includes a Genetic Algorithm Optimization module

Approach

- Design Document Development
- Prototypes / Proof of Concept Models
- Implementation
- Test Bed
- Fielding
  - Certification
  - Training
  - Support

Design Document Development

- Design Document development began in earnest in June 2005
- Dick Males took the lead on Design Document development
- Since that time the team has had bi-weekly teleconferences and one face-to-face at the end of July
- Based on these discussions the team came to a consensus on required features
- Design Document in final stages of development
- Should be posted on NETS site February 2006.

NaSS Overview - Modularity

- NaSS will be developed as a suite of models
- Each component model will deal with a specific aspect of the problem
- Facilitates modular development and testing at appropriate scale
- Module integration will occur at appropriate time

NaSS Overview - Modules

- System Network Model
- Genetic Algorithm Optimization model
- Data Analyzer
- Data Preprocessor
- Results Analyzer
- Visualization/Animation
- Agent-based Prototype

Modules – System Network Module

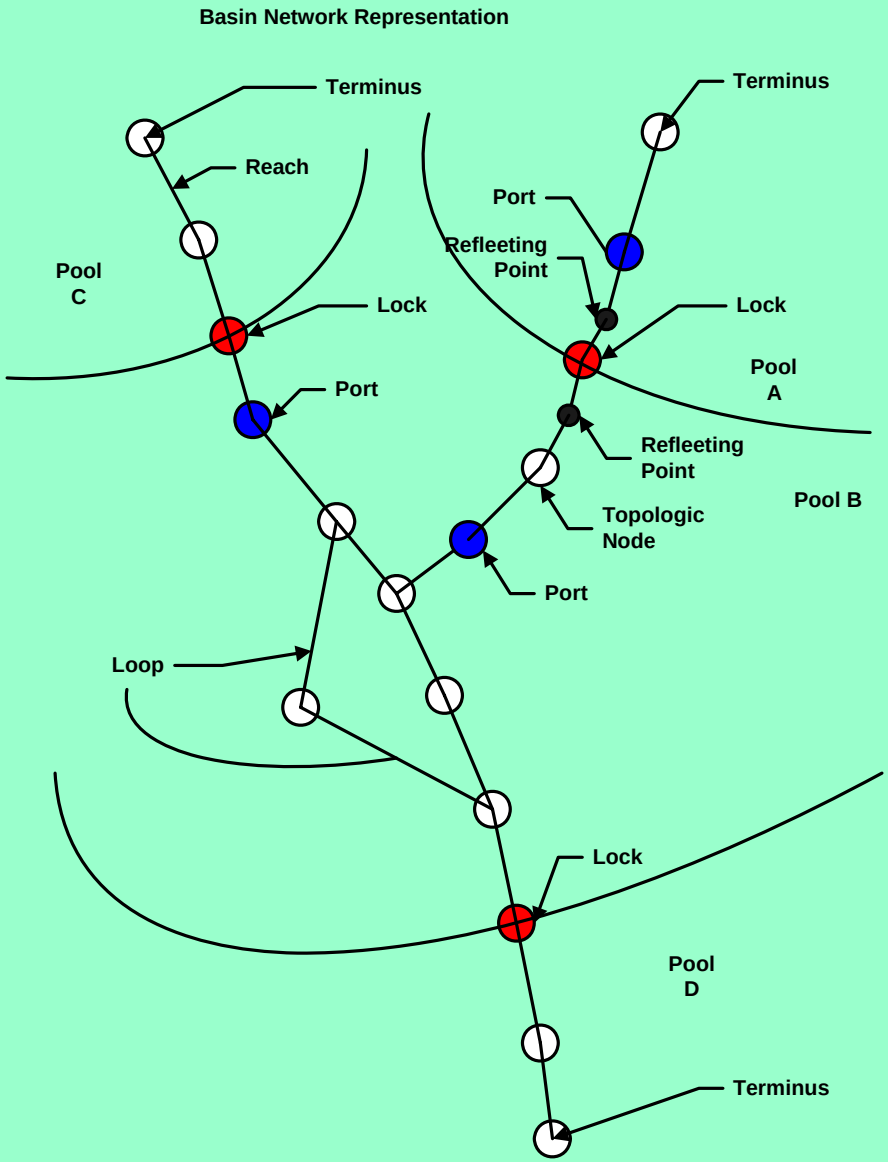
- System will consist of reaches, ports and locks
- Annual O-D-C commodity flows will be converted to tow-by-tow movements. These movements will “drive” the model.
- Refleeting may occur at various points in the system
- Shippers may respond to scheduled and unscheduled closures
- Will include conservation of equipment concept

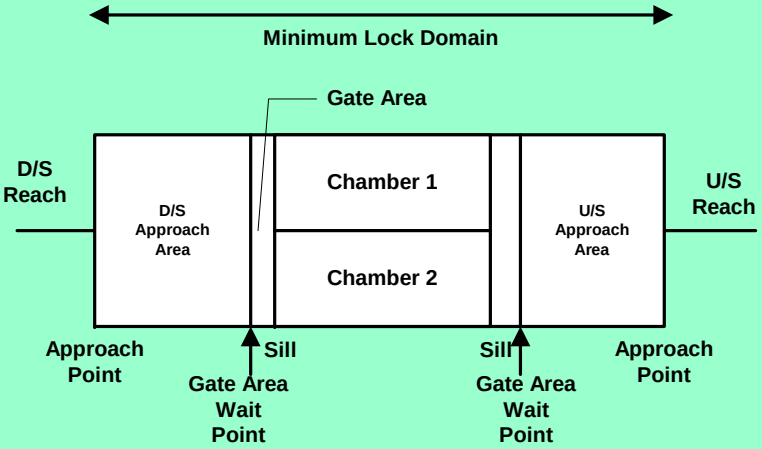
System Network Model

- Multi-lock Monte Carlo Simulation
- Extremely complicated real-world process
  - Many individual interacting decisions determine overall system behavior
- Understanding of problem, issues, is greater than ability to model
  - Simplifications Required

Modules – System Network Module

- Detailed Lock representation
  - Multi-chamber
  - Internal lock geometry
  - Multiple lockage policies which can change based on rules
  - Interference between vessels
  - Probabilistic component-based reliability of each chamber
  - Scheduled major maintenance closures
  - Four stage/three condition process
- Option to use Simplified Lockage Process


Basin Network Representation
Terminus
Terminus
Reach
Port
Refleeting Point
Pool C
Lock
Lock
Pool A
Port
Refleeting Point
Pool B
Topologic Node
Port
Loop
Lock
Pool D
Terminus


Minimum Lock Domain
Gate Area
D/S Reach
D/S Approach Area
Chamber 1
Chamber 2
U/S Approach Area
U/S Reach
Approach Point
Sill
Gate Area Wait Point
Sill
Gate Area Wait Point
Approach Point

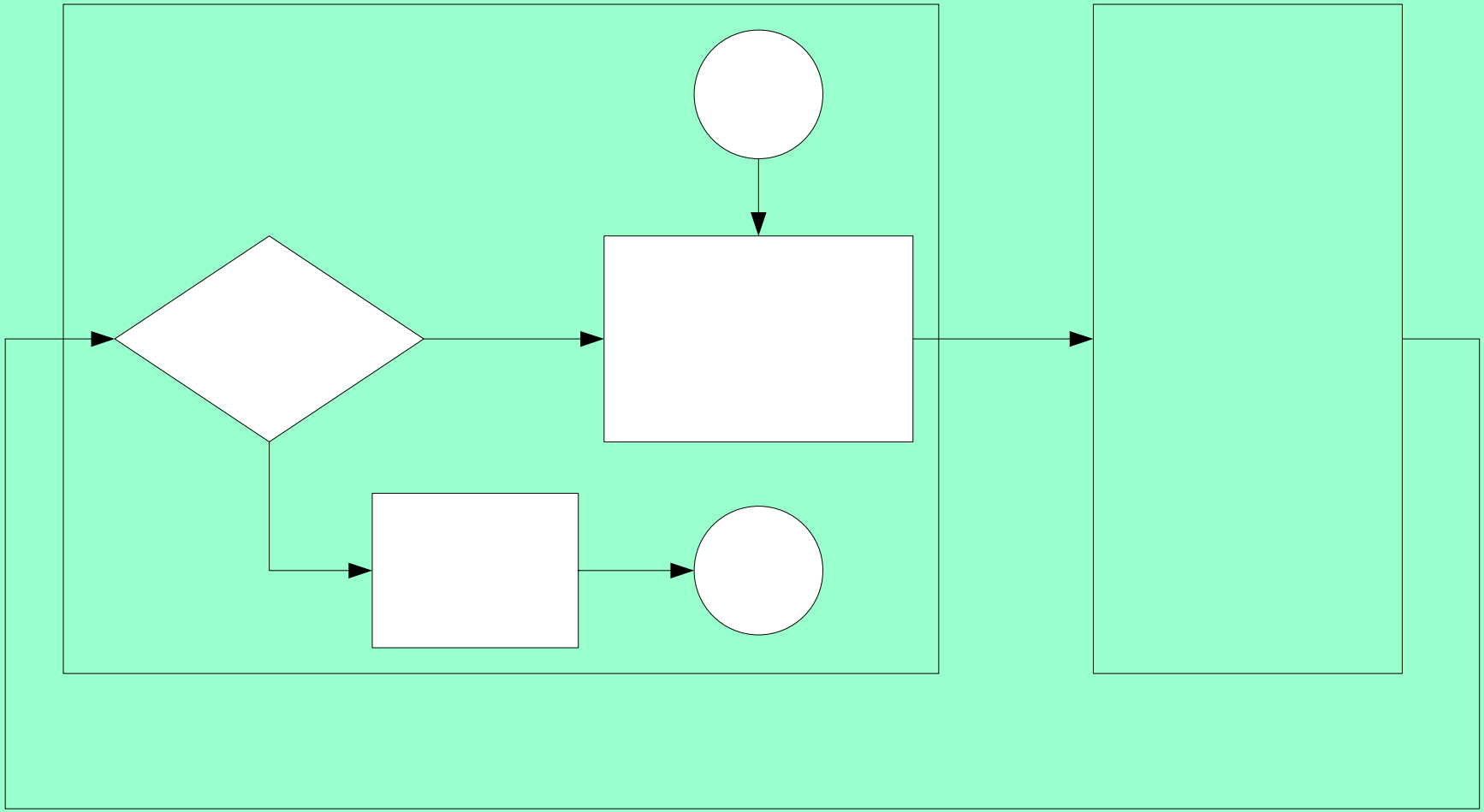
Modules – System Network Module

- Later phases will include ability to model traffic management schemes
  - appointment systems
  - tradable permits

Modules – Genetic Algorithm Optimization

- Paul Schonfeld presented details yesterday
- Will be used to optimize sequence and timing of system improvements
- Relies on three elements:
  - Optimization logic
  - System Network Module to evaluate plans
  - Translator to convert candidate plans into simulation input

Simulation-Optimization

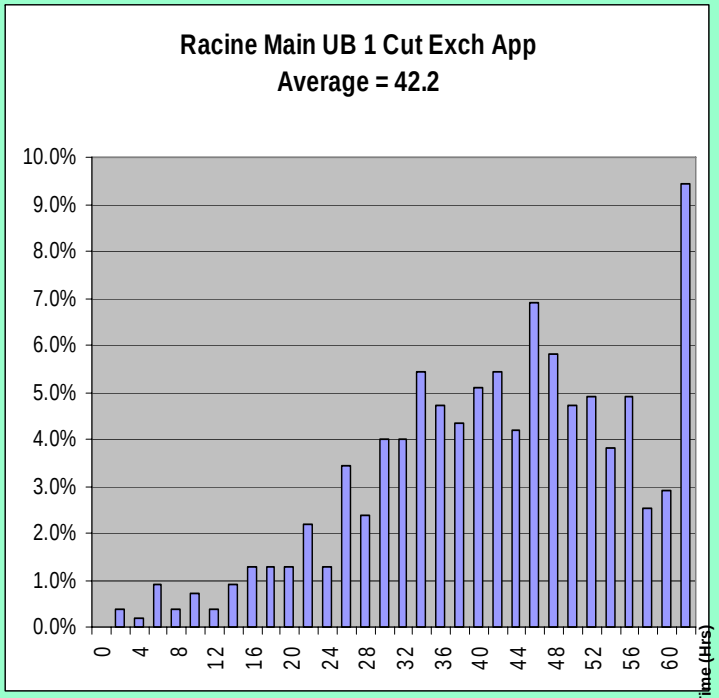


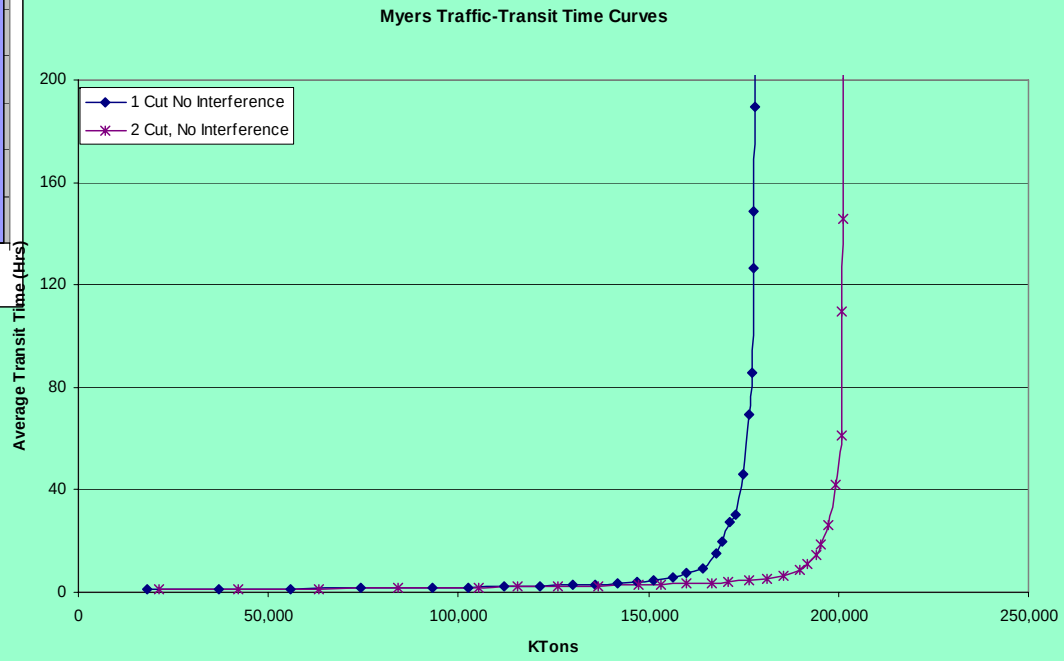
Op

Modules – Data Analyzer

- This module will be used to examine LPMS, WCSC, OMNI data
- Data of variable quality
- Data not captured for planning / modeling purposes
- Must be examined before usage
- Preliminary efforts
  - White paper on data quality
  - Analyses of data

Sample Analyses





Data PreProcessor

- LPMS, WCSC, OMNI raw data not directly suitable for modeling
- Extensive effort, data scrubbing, required
- Tool to simplify extraction of needed data
- Issues
  - LPMS data structure changing
  - Access to raw data?
  - Ability to influence data collection efforts?

Results Analyzer

- Monte Carlo Simulation can generate large amounts of information
  - Varying by time, space
- Tool Needed for Synthesis, Comparison
  - Reports
  - Graphics
  - Statistics
- Test Bed can dictate types of output needed/used in Corps studies

Visualization/Animation

- Aid to:
  - Testing
  - Understanding
  - Transparency
  - Marketing
- Existing examples
  - HarborSym
  - HSAM
  - LPMS data visualization
- Within Simulation
- Post-Processing Animation

Agent-based Prototype

- Interactions of individual decisions in environment determine system behavior
- Shipper decisions in response to outages, reliability, congestion
- Agent modeling technology
  - Implements this class of problem
- Simple agent-based proof of concept developed
- Prototype focusing specifically on shipper response

Current Activities

- Wrapping up Design Document
  - Ready in February
- Continued work on GA Optimization Module
- Continued work on animation module

Current Activities

- Preparing Scopes for:
  - System Network Model sans Detailed Lock Model
  - Detailed Lock Model
  - Data Analyzer/Preprocessor
  - Shipment Generator
- Researching Shipper/Carrier response to scheduled/unscheduled closures